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USSR Report

MACHINE TOOLS AND METALWORKING EQUIPMENT

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USSR REPORT

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CONTENTS

INDUSTRY PLANNING AND ECONOMICS

CEMA Agreement on Development of Machine Tool Sector Explained (Ede Zador; EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV, No 8, 1984)	1
Relative Complexity, Availability of GAP, GPS Described (P. Belyanin; PLANOVOYE KHOZYAYSTVO, No 7, Jul 85)	9
Status of Industry Modernization in Georgia Surveyed (ZARYA VOSTOKA, 15 Jun 85)	17

METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

Modernization of Gomel Machine Tool Building Plant Viewed (N. Bozhko; NARODNOYE KHOZYAYSTVO BELORUSSII, No 10, Oct 84)	20
Changing Product Mix of Kirov Plant Reviewed (G. Kazakov, V. Rayskiy; NARODNOYE KHOZYAYSTVO BELORUSSII, No 10, Oct 84)	25

OTHER METALWORKING EQUIPMENT

Briefs	
New Novolipetsk Plate Mill	32
Truck Plant Automation	32
Estonian Ferrous-Metallurgy Plant	32
Belorussian Industrial Lasers	32
Plasma-Spray Hardfacing	33
Minsk-Produced Lathe Postprocessors	33
Ganged Grinders From Orsha	33
Shipbuilders' Industrial Laser Improved	33

AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

Drawbacks To Certain Flexible Production Systems Noted (P. I. Chinayev; LENINGRADSKAYA PRAVDA, 14 Mar 85)	34
Justified Flexibility of Automated Production Lines Discussed (DVIGATELESTROYENIYE, No 5, May 85)	38

INDUSTRY PLANNING AND ECONOMICS

CEMA AGREEMENT ON DEVELOPMENT OF MACHINE TOOL SECTOR EXPLAINED

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 8,
1984 pp 43-46

[Article by Ede Zador, CEMA Sekretariat: "Activity of CEMA Organs: Cooperation in the Machine Tool Sector"]

[Text] At a high-level economic conference between the CEMA member-nations, the participating countries agreed on the need to encourage extensive cooperation in the machine-building industry and to direct this cooperation at providing key industries with high-quality and internationally competitive machinery and equipment. The division of labor under this cooperative effort will go deeply into both finished production as well as that of parts and components. Special attention is being given to developing industries that determine scientific and technical progress.

Agreement on Scientific and Technical Cooperation

On 20 December 1979, Hungary, the German Democratic Republic, Poland, Romania, the USSR and Czechoslovakia signed an agreement on cooperation in the field scientific and technical research. This agreement contained provisions on:

- the creation of prospective designs for automated lines, aggregates, their components and parts, transport systems, specialized and auxiliary instruments, equipment for adjusting the tool outside of the machine and new designs for heavy-duty and unique machines;

- development and improvement of NC machines and NC-machine complexes and of their mechanical components.

The agreement included two programs for scientific and technical cooperation on 53 different subjects. In accordance with these programs, the USSR and Czechoslovakia are presently producing experimental models of an automated revolving lathe and Bulgaria is producing an adjustable lathe that can machine the ends of shafts up to 1000 mm in length. According to decisions that it has worked out with the Soviet Union, Bulgaria is sending the USSR a semiautomatic NC chuck pearler for testing.

The collective efforts of the participating nations are also aimed at other projects and especially the creation of automated lines that can machine large machine parts and bodies of revolution. Technical specifications are being worked out for the basic components of NC machines being produced for related branches of industry. Unified standard sizes and basic parameters are being coordinated for broad-range active control devices for NC grinders, bearing sleeves and straight-line motion rolling-contact bearings along cylindrical guides, telescopic safety devices for machine and other items. Special attention has been directed at specialized and auxiliary instruments for automated lines and diagnosis and the work of NC machines.

Hungary and the GDR have jointly developed a three-coordinate subsystem for machine programming of NC mills with circuit control and the "Motor" control system to transmit programs for individual data-processing by small computers.

Much has also been done to standardize scientific and technical cooperation. In 1981-1985, 17 new CEMA standards were agreed upon and changes were introduced to 10 existing standards.

An important role in deepening cooperation in the machine industry and in accelerating scientific and technical progress in this industry has been played by the 2 December 1979 protocol supplementing the 1979 agreement. This document calls for the creation of 12 types of very scarce high-output precision machines including some to replace equipment imported from the capitalist countries.

The machine-building institutes, plants and associations of all of the participating nations are taking part in the realization of the agreement and its supplement. For 14 different themes, contracts have been signed or are in the process of negotiation. These themes involve the creation of new machines including NC machines, automated lines and computer-controlled automated sections.

Agreement on Specialized and Cooperative Production

The agreement on multilateral international specialized and cooperative production of metal-cutting machines including NC machines, automated lines, specialized, heavy-duty and unique machines, component items, elements, attachments and technological equipment for metal-cutting machines was signed on 10 September 1980 by CEMA member nations and Yugoslavia. This agreement was the culmination of several agreements from 1976-1980 that divided work into the production of:

- basic groups of metal-cutting and forging and pressing machines;
- equipment for tractor, tool and bearing production;
- lathes, multispindle lathes and semiautomatic lathes;
- and component articles, units, attachments and technological equipment for metal-cutting machines.

However, the agreement is not limited to just the above. It also includes cooperative work in the production of an entire series of new products. The list of items in this series was reflected by the name of the agreement and includes:

- general-purpose metal-cutting machines
- heavy-duty and custom machines;
- NC metal-cutting machines;
- special, specialized and aggregate machines;
- automated machine lines, machine complexes and technological lines;
- components, equipment and accessories for metal-cutting machines and NC machines.

The agreement covered a total of 786 items of equipment comprising 12 different technological groups. The overall volume of cooperative production for 1981-1985 amounted to:

- 57,419 metal-cutting machines;
- 372 complete automated lines;
- 791,154 components and attachments for metal-cutting machines.

Table 1 shows the volume by country of imports and exports.

One of the most important tasks for the cooperating nations is to reduce the amount of machine tools, forging and pressing machines and metal-casting equipment imported from capitalist countries. In connection with this, representatives of the cooperating nations signed on 25 April 1983 a protocol to supplement and elaborate the 10 September 1980 agreement and to develop specialization in 28 different types of scarce metal-cutting machines of various technological groups. Mutual deliveries of about 660 units are planned.

In order to reduce unjustifiable imports from capitalist countries, it was decided to organize in 1983-1985 delivery of an additional 391 pieces of equipment listed in the agreement.

As a result, in the last three years of the current five-year period the volume of cooperative trade has exceeded the terms of the agreement and exports and imports were increased by 1051 units (table 2).

On 25 April 1983, the Republic of Cuba also signed the agreement and protocol. In connection with this, Cuba will in 1983-1985 receive from the other

cooperating nations 909 metal-cutting machines, 210 of which will be supplied by Bulgaria, 122 by Romania, 522 by the USSR and 55 by Czechoslovakia.

To review how well the participating nations are meeting their cooperative obligations, Section 2 of the CEMA Permanent Commission on Cooperative Machine Building analyzes each year the realization of the agreement and protocols. As the 54th session of the section stated, the different nations are for the most part successfully meeting their obligations.

At the present time, a protocol to supplement, elaborate and extend the agreement to 1986-1990 is being prepared. Particular importance is being attached to some decisions made by the CEMA Executive Committee (97th and 102nd sessions) on specialization in the production of high-output precision metal-cutting machines including NC metal-cutting machines.

The most important task that will be dealt with at this time is implementation of a decision made at the highest level of the Economic Conference to, in coordinating economic plans, more closely bind scientific and technical cooperation to industrial cooperation. This involves the development and production of a series of different types of machines and equipment, in particular:

- high-output precision machines;
- NC machines;
- flexible systems of machines and NC machines;
- machines for use in the production of bearings.

In order to comprehensively examine the problems of scientific research, production and sale, the protocol to supplement and elaborate the agreement on specialized and cooperative production will be included in a program for creating new equipment and improving the old.

Joint Coordinated Plan

Cooperation in the development and production of NC machines is now conducted in accordance with the Joint Coordinated Plan of procedure for 1981-1985 which is to be based on work to create modern metal-cutting tools with numerical control and NC devices. This plan was approved at the 98th session of the CEMA Executive Committee. The plan sets tasks for the respective CEMA organs and international organizations of the CEMA member states such as their permanent commissions on cooperative machine building, radiotechnology and electronics, the Intergovernment Commission on Computer Technology Cooperation Among the Socialist States, the Interelektro International Economic Organization and the Organization for Cooperation in the Bearings Industry. Each of these organs is responsible for its own "sector" in the creation and organization of production of:

- NC machines and automated sections made from these machines;
- unified NC devices, programmable command apparatus and prospective unified measurement converters for NC machines and NC-machine sections;

- sets of modern microprocessors and other items of electronic equipment;
- prospective standardized electric drives and major motion drives;
- new types of higher-precision rolling-contact bearings.

On the instructions of the Executive Committee, the coordination of work according to the joint coordinated plan is to be done by the CEMA Permanent Commission on Cooperative Machine Building with the participation of the CEMA Secretariat.

Today the efforts of scientific-research institutions and the plants of the participating nations are concentrated on improving presently produced equipment, replacing obsolete models of equipment and in filling industry's orders. An important place among these tasks is taken by NC machines of the following basic technological groups: lathes, drills and bores, mills, grinders, gear-cutting mills, etc.

In improving the technical sophistication of the machine-building industry and in doing so re-equipping their national industries, the CEMA member nations now give special attention to the creation of metal-working centers and robotized complexes (NC machine and industrial robot), flexible production modules, lines and complexes).

This work is conducted both according to national plans and the agreement on multilateral scientific and technical cooperation for 1980-1985.

According to a decision by the 89th session of the CEMA Permanent Commission on Cooperative Machine Building, CEMA organs and international organizations of the member states prepared in 1983 plans and schedules for creating experimental models of NC metal-cutting machines and sections of these machines, unified second-line NC devices and programmable command apparatus, a prospective series of unified drives, measurement converters and precision rolling-contact bearings.

In the almost 5 years since the signing of the agreement, the individual national plans have succeeded in creating, manufacturing, testing and finishing the development of 146 new models of metal-cutting NC machines of various technological groups. Mass production was organized and schedules have been set for the production of new machine models (including 56 lathes, 13 drills and borers, 19 mills, 8 grinders, 3 gear-cutting mills, 5 others and 42 models of metal-working centers).

The Creation of High-Output Precision Equipment

In accordance with the plans set by the 102nd session of the CEMA Executive Committee, the commission examined the starting data submitted by the member nations on the needs of industry for 1986-1990 and the possibility of producing by 1995 high-output precision metal-working and casting equipment not covered by any existing specialization agreements.

On the basis of this data, Section 2 prepared and the commission approved the draft of a protocol to supplement the 20 December 1979 agreement. As we have already mentioned, it was signed by representatives of the concerned countries on 2 December 1983. The protocol includes a program for design and experimental design work in 1983-1985 on high-output precision machines, the production of which interested three and more countries. These included the following machines:

- precision-class IV lathes;
- precision-class V coordinate grinders;
- precision-class III all-purpose precision-tool mills;
- electro-abrasive template-boring machines with adaptive-programmable process regulation and planetary table movement.

In accordance with the supplement, the following work is now being done:

- technical requirements for 6 machines are being coordinated;
- documentation on two machines has been exchanged;
- components for cooperation on one machine are being manufactured;
- one machine is being developed;
- one section for finishing and feeding lubricating and cooling liquids is being tested.

Flexible Automated Production

Today, the automation of mass production is becoming increasingly important. New technical solutions are being found which are aimed at increasing labor productivity while saving power and material, increasing product quality and freeing workers from boring operations and hard physical labor. On the basis of metal-working centers, NC machines and sections of NC machines controlled by computers, we are seeing the increasing use of flexible production modules, lines, shops and plants.

A flexible production module is independently functioning programmable automated equipment that produces a certain type of part (such as a shaft). It is equipped with a memory and a tool-changing device, transport system, part loading and unloading system, quality control system, scrap removal system and a system for diagnosing and eliminating malfunctions. The system's flexibility is substantially increased if it includes programmable robots.

Flexible production systems and lines are two or more computer-controlled modules with automated parts storage. Their use in conjunction with computer-aided design automated control of technological process preparation has led to the creation of automated plants.

The advantage of these systems lies in the fact that they are faster and can be more quickly reset when the production is changed.

In the opinion of specialists, the use of these systems can increase labor productivity by 5-6 times because the equipment can be used for two or three shifts with a minimal amount of service personnel.

In accordance with the resolution of the 109th session of the Executive Committee of the CEMA Permanent Commission on Cooperative Machine Building, proposals are being worked out for the creation and introduction of computer-controlled flexible automated technological complexes in various branches and sectors of the machine industry.

Realization of the enterprises planned in this industry by our fraternal nations will bring about some fundamental advances in the structure and technical sophistication of socialist industry as well as the fulfillment of tasks put forth by the Economic Conference of CEMA Nations.

Table 1

Country	Metal-cutting tools		Automated lines		Components and parts	
	export	import	export	import	export	import
Bulgaria	6110	2369	20	---	17,793	79,230
Hungary	5204	2713	---	3	1500	31,472
GDR	8309	13,131	352	---	133,104	137,933
Poland	2806	7739	---	2	20,770	100,105
Romania	10,542	2990	---	---	581,497	1680
USSR	16,582	11,542	---	367	1350	433,535
Czecho- slovakia	5182	14,918	---	---	20,510	6069
Yugo- slavia	724	57	---	---	14,930	1430
Total	55,459	55,459	372	372	791,454	791,454

Table 2.

Country	Export	Import
Bulgaria	8	15
Hungary	---	1
GDR	---	167
Poland	91	9
Romania	534	10
USSR	102	823
Czecho- slovakia	45	26
Yugo- slavia	271	---
Total	1051	1051

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INDUSTRY PLANNING AND ECONOMICS

RELATIVE COMPLEXITY, AVAILABILITY OF GAP, GPS DESCRIBED

Moscow PLANOVOYE KHOZYAYSTVO in Russian No 7, Jul 85 pp 19-25

[Article by P. Belyanin, corresponding member of the USSR Academy of Sciences:
"Flexible Automation of Machine building--Status, Difficulties, Problems"]

[Text] Between the late 1960s and early 1970s, when Soviet machine building was already using a sizeable number of NC machine tools (whereas the NC machine park at individual plants was as large as 300-400 units), the need arose to boost the efficiency of utilization of this costly and hard-to-operate equipment. The best solution of the problem seemed to be a group control of NC equipment by computer, which in fact gave birth to the concept of flexible manufacturing systems (GPS) in the form of multiproduct, easily-adjustable (by change of programs) automatic lines and automated sectors (primarily in the machining processes). The first such system, developed in the USSR in the early 1970s and performing with success at a series production enterprise, was the ALP-3-1 adjustable automatic line, which puts out a broad assortment of very intricate body parts without machinists. This line is still being used in the current five year period.

As already mentioned in this journal*, a higher form of integration of all kinds of technical production resources is flexible automated manufacturing (GAP). This embraces automated systems for machining, assembly, material handling and transport, tool distribution, supply of raw materials and stock, removal of production scraps, testing, measuring and inspection of product quality, diagnostics of faults, detection and correction of malfunctions in all the technical resources being used. GAP also include systems for automation of scientific research (ASNI) and automation of the functions of all varieties of engineer directly involved in the manufacturing: designers, technologists, standards developers, dispatchers, programmers, production managers, supervisors, etc. on the basis of electronic computer technology (chiefly the SM series and personal computers). GAP as described above does not yet exist, but its development will come in the near future. This will allow the implementation of the concept of industries with few or no people, operating reliably round the clock over a span of many years with brief shut-downs for preventive maintenance to replace worn parts.

* Cf. "Planovoye khozyaystvo", 1984, No 12.

The development of flexible automated manufacturing will require the creation of various types of new machining, casting-and-forging, assembly, inspection, testing and other automatic equipment with microprocessor control, as well as the development of a huge volume of software, training of specialists of the required qualification and solving of a number of major complicated scientific problems.

The cornerstone of GAP is the development and broad introduction of GPS, which consist of two or more (up to 20) flexible machining production modules unified by a single automated materials handling and transport system (ATSS), and occasionally also an automated tool distribution system (ASIO), and centralized computer control (KASU).

Today the world park of operating GPS (excluding the USSR) numbers around 230-250 systems. Practically all of these are used for machining of parts (up to 65 percent for machining of body parts; 12 percent for lathe work, 8 percent for fabrication of flat parts, the remainder being able to machine parts of various groups). In the USSR, 60-70 machining GPS have been built and put into service, a sizeable number of which were developed by the Scientific Production Association [NPO] for Metal Cutting Machines. Just above 40 percent of the world park of flexible manufacturing systems comprises up to 5 modules, a third of the park between 6 and 10, the remainder 11 or more. Most often these systems employ NC machines of the "Machining Center" type (above 35 percent), although other NC machines are also used (turning and drilling-reaming, 18-20 percent; milling, around 10 percent; and grinding, less than 8 percent).

At their inception, it was believed that GPS could be used most rationally in small series production. But today they are also being used in large series and even mass production. In 1984 nearly two-thirds of the world park of GPS (excluding the USSR) was employed in small and medium series production (above 35 percent in machine tool construction, 6 percent each in heavy industry and aviation, around 4 percent in ship building), the remainder in mass and large series machine construction (automotive industry above 19 percent, agricultural and tractor industry above 16%). They are starting to be used in instrument, Diesel, electrical engineering and other sectors of industry.

Flexible machining systems are a response to the changing economic, social and other social needs. These changes have dictated a sharp increase in the assortment of machine products necessary to the full satisfaction of the demands of the economy and the needs of the population, a shortening of the time for setup of an industry and turnout of products, and a significant raising of the requirements for quality of articles and machines. In this connection there also arises the urgent necessity of economizing on all types of resources (foremost labor, due to the reduced proportion of workers, especially those in the machining industries) and protection of the environment against the deleterious effects of industry. There is a need to improve the working conditions and raise the enthusiasm, especially in the realm of material production, which is the area of most vital importance to society.

Only an industry that can quickly respond to the demands of the customer and adjust to the manufacture of new products can be progressive and efficient in the new environment. It should be furnished with the latest technologies and equipment, enabling the production of articles of the highest quality, dependability and lifetime, and should employ highly-qualified personnel. Not less important is the requirement of economy, i.e. minimum production costs for the products and rational utilization of all resources, including the most comprehensive and intense exploitation of past physical and mental work.

Flexible manufacturing systems are indeed capable of assuring the highest efficiency of the machine building industry and best satisfaction of the consumer demands, without which it is not possible for an industry to compete on the world market today and show a high profit, or avoid an overstocking of unwanted products and inefficient outlay of material resources.

The introduction of GPS in no way implies the abandonment of other methods and means of automation of production. Each of these has its own area of rational utilization where it is most effective. GPS does not eliminate these means, but only multiplies and supplements them.

Soviet and Western experience shows that the feasibility of employing a particular technological equipment with varying level of flexibility and automation (automatic lines, flexible manufacturing sectors, self-contained modules, etc.) is largely determined by the volume of annual parts production and the number of standard sizes. Thus, if the need is to produce one or two standard sizes in a volume exceeding 2000-5000 items per annum, it is advisable to use conventional automatic lines with hard-wired control, as well as rotory and rotory-conveyor lines; for 2-8 standard sizes with a volume of 1000-15,000 items, adjustable automatic lines with some flexibility; for a volume of 50-1000 parts of one of 5-100 standard sizes, GPS and so on. In principle we cannot rule out the use of universal equipment with manual control: this may prove more effective if a very small number of parts is being produced and the cost of programming the process cannot be recovered.

One of the characteristics of flexibility of GPS is the assortment of handled parts (the larger the assortment, the greater the flexibility). This varies in broad limits: from 2 to 200 or more items. Of all the currently used systems, 7 percent work on less than four types of part, 25 percent on 4-9, 40 percent on 10-100 and the remainder work on more than 200 kinds of parts. However the latter group is currently characterized by a lower level of automation of the auxiliary processes.

Important characteristics of flexibility are the time to switch the system to work on a different kind of part (not longer than 20 seconds in the ALP-3-1 and ALP-3-2 lines) and the time to set up a production of a new kind of part, including engineering (design of the technology, control programs, tools and equipment, etc.) and technical (fabrication of the tools and equipment, etc.) preparations.

Unlike conventional methods of automation of large series production (especially the highly-effective hard-programmed, flow and conveyor lines of mass production), flexible manufacturing systems possess great flexibility and mobility, enabling an adjustment to the machining or production of a new part (product) in a short time (often several minutes or even seconds). They are universal, i.e. able to work on a broad assortment of parts (only the specifications such as dimensions of the work zone are a limiting factor, but not the nature and characteristics of the internal communications and control). Moreover, GPS have little sensitivity to partial (or sometimes even major) modification of the design of the part being produced, since the necessary and sufficient reaction of the system to such modifications is most often a correction or replacement of the control programs. Among the indisputed advantages of GPS are: the long-delayed obsolescence, which in some cases greatly exceeds the term of physical wear of the technical resources (equipment), since the systems operate on the basis of extremely broad capacities for automatic reprogramming; excellent adaptability to changes in the production conditions, allowing a variation of the workload of the systems within the framework of the part assortment being produced (e.g. when a certain piece of stock is unavailable or when a certain machine has failed); and the possibility of a real control of product quality, not only by modifying the design, but also through the conditions of machining and fabrication, e.g. by the use of materials with different characteristics, for which only corrections in the automatic production program are needed.

Flexible manufacturing systems transcend conventional universal automation for small series production (e.g. NC machines) in a number of important indicators. Among these are the higher labor productivity as a result of automating all the auxiliary processes; improved workload and utilization of the technological equipment (higher work shift coefficient); reduced amount of equipment in use; reduced amount of equipment required and, consequently, reduction in the required production space; reduced requirement for machinists and attending personnel (especially in the second and third shifts); shorter production cycle and improved utilization of working capital by shortening the unprofitable lie-around time of stock and parts between machining operations; lower net costs of the manufactured products.

Flexible automated systems create the opportunity for organization of production on the progressive principle of "timely production", when each part is manufactured and supplied at a strictly determined time, dictated by the production pace of the assembly groups of the overall product. All elements of the production process are subordinated to the pace of assembly of the product; the materials and other components of production are supplied to the shops only as needed, and are not stockpiled at storage points. As we observe, the "timely production" principle assures optimal reserves of raw materials, purchased parts and complementary parts. This principle is best suited to the conditions of small and medium series production, which are usually characterized by the presence of sizeable buffer reserves, resulting in major losses in the form of uncompleted production.

The integrated control systems used in GPS, together with group control of the equipment, enable a regulation of the production pace with issuing of instructions even to individual work sites.

The advantages of flexible manufacturing systems are presented more forcefully when many such systems are combined into a flexible automated industry, where the time and cost of preparation of production (especially that of complicated products) are significantly (several times over) reduced. Elements of automation of the preparation of production (e.g. automation of the development of technologies and control programs) are already in wide use, which greatly improves the effectiveness of GPS.

Even with the high level of GPS, bestowing indisputable advantages in use, we should not lose sight of certain features that distinguish this from conventional means of automation of production. In particular, there is the sizeable structure and design complexity, impeding the achievement of high reliability characteristics of the systems and requiring highly-trained specialists of new skill and training for their operation (systems engineers, mathematician-programmers, electronic engineers, etc.). A noteworthy feature is the high cost, which lengthens the payback period (according to the present standards this period should not exceed six years). Another difficulty is the need for the supplier to assemble all the technical resources of the flexible system, which are produced not only by different factories, but often by different branches of industry, which creates certain difficulties in the installation and debugging of the system. Besides the technical resources, all the software must also be furnished to the customer.

Even so, these shortcomings in our opinion should not stand in the way of adoption of flexible manufacturing systems, especially as the expanding applications of the systems and the organization of thorough standardization of the hardware and software will to large extent capitalize on past intellectual and physical effort and substantially shorten the time and cost for development and introduction of GPS and GAP. A large reserve will be created by the use of the principle of modular assembly design from unified parts and components. Thus, the applications of GPS and GAP enjoy an important future.

Today, alongside the use of GPS in machining, systems are being developed for practically every kind of technology: casting, forging, heat treatment, painting, welding, assembly, testing, manufacture of printed circuit boards and so forth. And we may anticipate that, in a number of branches of the machine industry, a substantial portion of the technological equipment will be combined into computer-controlled complexes at the turn of the century. But this lies in the future. For the present there are a number of first-priority problems to be solved. Primarily, improved dependability and longer work life of currently-operating and newly-developed systems and all their component parts. The operating time till failure of a NC system must be raised from 30-50 h to 500-1000 h or more, that of the control computers in GPS up to at least 4000-5000 h, the reliability of the machine tools and other technological equipment must be increased 2-3 fold, and the durability

of the automatically-changed tools used in the systems must be increased 5-8 fold. The Ministry of the Machine Tool Industry should sharply increase the production of high-strength tools and the delivery of such to the plants of the various departments, as well as computer-controlled monitoring and measuring instruments. The Ministry of Instruments must quickly double or even triple the production of highly-reliable multicoordinate NC systems with fault diagnosis features, as well as increase the production of specialized (specific) computers of type SM-1420 and SM-1800. The Ministry of the Machine Tool Industry, the Ministry of the Electrotechnical Industry and other ministries must organize a widespread production of GPM and GPS for assembly*, welding, cutout of sheet material, stamping and casting of billets. The current production of such equipment does not comply with the demands of many sectors of the machine industry or the economy as a whole.

An important problem that will present some difficulty in the adoption of flexible manufacturing systems is their full and rational workload. A full three-shift workload of GPS should be the main concern of the industrialists, for otherwise the concept of flexible automation is discredited. And here the main priority becomes the technology of group machining of parts which has been forgotten by several of the small series production enterprises (which constitute the majority). Without a unification of like parts of different nomenclature into groups it is difficult if not impossible to achieve a full workload and an operation in two or three shifts. Consequently, it would not be possible to achieve a payback of the system in even the standard term, let alone a payback in 2 or 2.5 years. Full workload of GPS is possible in only two cases: when the system is working on several varieties of mass-production parts or when it is being used to produce a large assortment of small series parts combined into groups on the basis of group technology principles.

No less important a concern of the GPS developers should be the assurance of high dependability. Because of the unsatisfactory dependability of the current systems hardly a work shift goes by without equipment malfunction, requiring much time to correct. Hence the factories adopting GPS are reluctant to abandon the old technology (keeping it around for any eventuality), which also impedes the advance to flexible automation.

Also urgently in need of a solution is the problem of training the engineers and technicians needed to develop, build and operate GPS. As long as the operation of the systems is entrusted to untrained (or poorly-trained) workers,

*The production of automatic assembly machines has sharply risen recently in the most-advanced capitalistic countries. Under such conditions it is not hard to predict a boom in the development and adoption of flexible manufacturing systems for assembly, especially as the specific share of the latter in the structure of the labor intensity of manufacture of modern machinery is seldom less than one-third, and in some cases is more than one-half, whereas assembly has remained a manual, relatively nonmechanized process up to the present.

which is often the case today, crude breakage and malfunctions of technical resources will occur, significantly lowering the overall working efficiency of the system. A correct and well-tried solution is the retraining of specialists of the GPS customer plants at an educational center on the premises of the supplier factory. Such centers have already been created at a number of factories of the Ministry of the Machine Tool Industry (e.g. the Ivanovo Machine Tool Production Association im. the 50th Anniversary of the USSR will not send its customer a newly-built system until all the operators have undergone a full course of instruction at the educational center).

Clearly, GPS should be introduced primarily at plants where many NC machines are in use, with successful computer centers and programming departments and cadres of qualified technologists, maintenance workers and operators. In such situation it is easier to create the conditions of efficiency functioning of the system: selection of the required assortment of parts, assurance of the workload and multiple-shift operation of the entire equipment, so that the costs of acquisition and operation of the GPS are paid back in the established term for automation facilities.

Experience has shown that, under normal operation, the use of flexible manufacturing systems in small series production can sharply improve the intensity of utilization of the technological equipment. Thus, the machine workload ratio is increased by at least twofold. Because of the unsatisfactory dependability and not always well-organized operation of NC machines, this does not exceed 0.4-0.6, but when they are built into GPS it increases to 0.8. The machine shift coefficient in flexible manufacturing is increased to 2.5-3, i.e. a 24-hour operation is achieved. Today the shift factor in various sectors does not exceed 1.3-1.6.

In small series and series machine manufacturing the parts are produced in lots, meeting the production demands for 3-6 months, whereas in GPS the parts initiation time can be lowered to 0.5 months or less, shortening the parts machining program by a factor of 4-10.

Thus, the adoption of flexible manufacturing increases the equipment output by a factor of 2-4, enabling a technology with minimum number of workers.

The broad dissemination of GPS in the various sectors of the economy and the development and introduction of the first GAP signify radical changes in industry. But the reorganization of industry, the changing of its features, is a government-wide task, requiring the implementation of major policies for the reoutfitting of machine manufacture on the basis of flexible automation.

Implementation of the government projects for development and adoption of flexible manufacturing systems, as well as the implementation of the All-Union scientific-technical project program for 1986-1990 and the period

up to the year 2000, ratified by the USSR Gosplan, the State Committee of the USSR Council of Ministers on Science and Technology, and the USSR Academy of Sciences, in the field of development of flexible automated manufacturing and their use in the economy, have called upon a large complement of scientists and workers, technicians and engineers, and specialists of various skills. The range of participants in these projects will continue to expand. The successful implementation of the scheduled plans will assure further progress in the economy, improve the effectiveness of production, intensify production and also improve the working and living conditions of the Soviet people.

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INDUSTRY PLANNING AND ECONOMICS

STATUS OF INDUSTRY MODERNIZATION IN GEORGIA SURVEYED

Tbilisi ZARYA VOSTOKA in Russian 15 Jun 85 p 2

[Article by the Georgian SSR State Committee on Science and Technology: "Scientific-Technical Progress and Problems: Georgian Machine Manufacturing--Giving Priority"]

[Text] In the structure of Georgia's industry, machine manufacturing occupies one of the leading positions. The enterprises of this branch are specialized for the output of many types of products, among which are main line electric locomotives, metal-cutting machine tools, automation and computer facilities, instruments, cultural-domestic goods etc. In the 11th Five-Year Plan, the branch structure of machine manufacturing has improved significantly. In the total volume of machine manufacturing, the proportion of electronic industry, radio industry and instrument engineering has grown.

In 1983-1984 the machine manufacturing enterprises of union ministries organized the production of new types of products and modernized more than ten types of machines, tools and instruments, which facilitated an increase in production efficiency and product quality. The individual types of machines and tools that have been developed, which are being produced or are at the stage of lot organization, are comparable to or surpass the best domestic and foreign analogs in terms of their technical indicators. To these one might add the main line 12-axle VL-15 electric locomotive, low-power electric engines of various modifications and others.

In recent years there has been observed a positive tendency to locate machine manufacturing enterprises in small cities and settlements; the qualitative structure of the stock of technological tools has improved noticeably and the tool rotation coefficient has increased in basic production. On the whole, work is ongoing at all of the republic's machine manufacturing enterprises to improve product quality. Robotization and computerization schemes are being developed.

And nevertheless, in spite of certain positive moments, it is impossible not to talk about those deficiencies and unsolved problems that are holding up the development of the machine manufacturing complex of the republic. We are talking about the currently low level of technological specialization and the delay in construction time and reconstruction of plants. Practice convinces us that from year to year the quotas for reductions in the consumption of rolled stock of ferrous

metals are not being fulfilled, production capabilities are clearly not being sufficiently utilized, idle time for machines and tools is still high and the labor turnover is high. At certain of the branch's enterprises work on improving the quality of goods produced and raising the technological level of production is being carried out unsatisfactorily. For example, the Gruzsel'khoz mash and Gruzpushchemash production associations, the Poti Control Generator Works and certain others are not fulfilling quotas for the organization of new types of production and for the removal of obsolete equipment from production. The goods being produced here do not meet the modern requirements of the national economy. On the whole, out of 20 products classified as obsolete and recommended for removal from production in 1983, far from all of them had been removed from production in 1984. And, it must be said, such clumsiness and sluggishness is becoming the basic reason for the continuous growth in the proportion of products that have been in production for more than ten years. One negative effect of the obsolescence of machine manufacturing output and the reduction in its technical level is its poor ability to compete on the foreign market. It is enough to say that, in spite of the growth of high-quality output, the proportion of machines and tools remains too small--it comprises 5.3 percent of the export production of the republic, and this is two times lower than the union-wide figure.

As the chief strategic lever for the intensification of the national economy, the party is putting at the forefront the acceleration of scientific-technical progress and requiring revolutionary changes that can be obtained as the result of changing over to principally new technological systems--to equipment of the latest generations--and retooling all branches of the national economy. It is no coincidence that a CPSU Central Committee session emphasized that the machine manufacturing industry has the final say.

It is very important to give this development priority and to accelerate the growth rate of the branch 1.5-2-fold in the 12th Five-Year Plan. This efficient large-scale program orients every labor collective, all communists and every worker toward increasing efforts tenfold, having directed them toward the speedy transfer to the production of new generations of machines and tools that are capable of guaranteeing the institution of the most progressive technology, of increasing labor productivity many times over, of reducing materials consumption and of increasing capital productivity. Such work is already being carried out in the republic. A program for 1985-1990 to increase the quality and competitiveness of production has been worked out by the Georgian SSR State Committee for Science and Technology, together with Gosplan and the republic directorate of USSR Gosstandart. It stipulates the implementation of specific measures directed toward increasing the technical level of production and the quality of output by means of utilizing modern high-productivity equipment, implementing new advanced technological processes, improving the design of goods, etc. The CPSU Central Committee and the USSR Council of Ministers have recently made a number of resolutions, in which great attention is paid to the necessity of working out and implementing economic and ethical measures that facilitate increasing the incentive of every member of the labor collective in modernizing equipment and technology, improving the quality and consumer qualities of a certain part of industrial production and bringing it to a world level. In this connection, specific measures have been developed by the Georgian SSR State Committee and the republic directorate of USSR Gosstandart; they are directed toward guaranteeing the quality

of goods in production. In order to realize them, together with other measures, it is necessary to seek additional fund-generating channels for stimulating the material interests of labor collectives that produce competitive goods.

At the present time in Georgia a number of scientific-research institutes and special design bureaus have been set up, where prototypes of metal-cutting machine tools, electrical engineering products, tools for the food industry, instruments and automation and computer facilities are designed, built, tested and instituted at the republic's machine manufacturing enterprises. The implementation of scientific and technological achievements will raise the level of equipment of labor no less than 2-3-fold and labor productivity 2.2-fold. An efficient course has been taken for the development of individual sub-branches of the machine manufacturing complex: electrical engineering, instrument manufacturing and automation facilities, machine-tool manufacturing and the instrument industry, and others. Putting the above program into effect is the most efficient way of retooling all branches of the national economy, which in turn will allow a sharp increase in the productivity of domestic labor.

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METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

MODERNIZATION OF GOMEL MACHINE TOOL BUILDING PLANT VIEWED

Minsk NARODNOYE KHOZYAYSTVO BELORUSSII in Russian No 10, Oct 84 pp 12-13

[Article by N. Bozhko: "The Plant Is Small..."]

[Text] The Gomel Machine-Tool Components Plant is a comparatively young enterprise, it is not even a quarter-century old. But in this short time it has become one of the best in USSR Minstankoprom [Ministry of Instrument Making, Automation Equipment and Control Systems].

Various resources for production automation, computers and robots are being used increasingly widely in machinebuilding. GZSU [Gomel Machine-Tool Components Plant] is trying to keep pace with the times. They have here 80 special and specialized machine tools, 60 with NC. A robot-engineering complex and two NC machining centers have been introduced recently.

Twelve years ago the question of the plant's mastering the production of beam drills came up. The appropriate documentation was sent to Gomel. In arranging to set up for production, the designers simultaneously began to work on modernizing the article. Time has shown that the plant's people took the right path. Soon the machine tool was recognized as one of the best in the country. The designers, however, did not stop with this. Four years later a special group was created here for designing the next model--the 2K52-1. The group was under design engineer I. Taranov. In a short time the documentation was prepared and a model that was on a par with the best foreign counterparts was created. The excellence of the new transportable beam drill was that it could be used effectively for machining holes (placed at angles in various planes of large-dimension parts) in tooling, assembling and production departments, repair shops and repair bases and aboard ships. Setting up and tending the machine was simple; does not require high qualifications of tending personnel. The new item has been produced serially since 1982. It has earned a good reputation among users.

The growing demands for metal-machining equipment and for intensifying competitiveness on the foreign market require of designers constant study and perfecting and updating of articles. Today, for example, Gomel plant people are working on still more modern beam drills. Besides finished machine tools, the plant is also producing various components for them: aprons, feed gear boxes, cutter heads with automatic indexing that are intended for NC lathes, a selection of electromechanical clamping heads of the EMG series, and so on.

The heads are basically a new type of output for the plant. They were very difficult to produce. Design developer V. Baranovskiy was soon assigned to developing them....

"I saw that the job was in difficulty, and I wanted to help my colleagues," says Valeriy Valentinovich. "But there were no definitive concepts. I read a mass of the technical literature. When the head became ready, I proposed my variant."

V. Baranovskiy's design proved to be better, simpler and more reliable. Later his engineering solution was recognized as an invention. V. Baranovskiy is an active rationalizer, the originator of many practical suggestions. Right now the engineer is again on the hunt: he is developing an automatic tool head for lathe-type machining centers.

Inquisitiveness and the ability to find original solutions are characteristic of OGT [chief manufacturing engineer's department] mechanical engineer R. Vinokurov, deputy department chief A. Ptashinskiy and heat specialists A. Volkovich and N. Lopatenko. For example, chief of the engineering office A. Tamilov alone submitted 35 rationalizers' suggestions last year, 12 of which were put into production. The economic benefit was 5,524 rubles. The rationalizer's suggestion of A. Ptashinskiy to change the technology for machining one of the parts of a machine tool helped to reduce the labor intensiveness of its manufacture and to save more than 60,000 kWh of electricity.

Last year alone 153 innovations in all were introduced at the plant. The economic benefit from using the rationalizers' suggestions and inventions in the country's economy exceeded 2.5 million rubles.

Right now the plant's engineering services are oriented to producing components for highly productive NC machine tools that can operate within robot engineering complexes. Designing them started with an analysis of the best domestic and foreign counterparts and the fabrication of experimental models. The plant has already mastered the output of automated 6- and 10-position cutting heads. Simultaneously, documentation is being developed for automated cutting heads with autonomous tool drive. These articles correspond in their specifications to the world's best models.

Eight standard sizes of "gripping hands" have been developed for robots. These components are extremely complicated in design and are intended for the manipulation of parts and blanks of the most diverse configuration. In the near future the creation of an automated flexible-production section for manufacturing robots with load-lifting capacity of up to 50 kg will be undertaken at the ZSU [machine-tool components plant]. The robots will take upon themselves not only the mechanical machining of parts but also the processes of pressworking, forging.... Thus the plant's work will free people from labor-intensive operations, labor productivity will be raised, and the problem of saving energy, metal and other resources will be solved. Incidentally, something must be said about the latter especially.

It would seem that the ZSU's production volume is not so great, comparatively, and the product is compact, not distinguished by great materials consumption. Saving under such circumstances is not simple. But in 1 year alone the machine-toolmakers saved 110 tons of hot-rolled section, 30 tons of rolled

pipe, 152 tons of iron castings and 3 tons of bronze castings. All this was achieved by reducing the allowances for mechanical machining and converting the technology to more progressive blanks (rolled products and section and aluminum, iron and steel castings) and to the wider use of plastics.

For example, the introduction alone of friction welding enabled 10 specific casting blanks to be converted from closed-impression die and other forging to welding, 48.5 tons of ferrous-metallurgy rolled products to be saved per year, and the metal-utilization factor to be increased to 0.65. One of the beam drill parts that had been made of grade-45 steel is now made of aluminum. As a result, 3.2 tons of ferrous metals were saved.

The galvanic production facility is working to install a new automatic loading device for an oxidizing line with automatic feed, which will enable production sophistication and labor productivity to be raised and coating quality to be improved. A benefit of 20,000 rubles is expected. Moreover, this year it is planned to use parts made of powdered materials and to introduce hot heading, taper rolling and other industrial processes that are aimed at saving metal.

One of the plant's main problems that it is working on is improvement of product quality. It is to this goal that engineering preparation for production is aimed. Each part is studied at a meeting of the engineering council with the participation of the chief specialists, design developers and technical personnel of the departments and the OTV [quality-control section]. Preventive monitoring of technical processes and equipment and checking of the tooling also are called for. All these procedures are spelled out by the enterprise's standards, which are part of the KS UKP [integrated system for product quality control] that has been in operation at the plant since 1976.

For purposes of technological support of quality and of raising the competitiveness of the equipment produced, last year the plant concluded 13 agreements with various scientific-research and design institutes. Collaboration with the Belorussian SSR Academy of Science's INDMash [Institute for Machinery Reliability and Longevity Problems], the NPO [Science and Production Association] for Powder Metallurgy, and the Belorussian Institute of Railway Transport Engineers is being developed most fruitfully.

The basis of quality control is authentic information that will enable the operating process to be followed responsively, from mechanical machining of parts to testing of the finished product. There are more than a thousand special measuring devices at the plant. For example, in collaboration with Orgstankinprom [State Industrial-Design and Experimental Institute for Organization of the Machine-Tool and Toolmaking Industry] and NII [Scientific-Research Institute] for the Machine-Toolmaking and Tooling Industry, a series of instruments for monitoring interaxis distances and deviations from precision and perpendicularity in frame parts has been developed and introduced. The instruments are equipped with inductive sensors and electronic reporting devices. They are convenient to operate and highly productive. Recently the BV-4100 active-monitoring instrument for a circular-grinding machine was mastered, and instruments for setting cutting tools outside the machine were introduced.

All this has enabled the share of highest-quality category products in standard net output volume to be raised to 61.5 percent. The businesslike approach is carried over here not only to basic output but also to the so-called "consumer goods."

It is known that new output is at times met with suspicion. The ZSU attitude is special--its brand guarantees high quality and longevity. Obviously, it was because of this that USSR Minstankoprom [Ministry of Instrument Making, Automation Equipment and Control Systems] charged the plant in 1979 with filling an order to produce casters for heavy Olimpiyskiy wood furniture. It is true, the casters were not received right away. For the experimental model did not stand up to testing, even in the plant's experimental section.

Design developer A. Krupoderov had been engaged in finishing-type work. He studied the drawings and test results carefully and found an original solution. The new design for the caster met all the requirements and passed its tests successfully. In 1980, 300,000 units were manufactured. The next year, orders rained down from furnituremakers of the Ukraine, Moscow and many of the country's cities. It turned out that the casters, fortunately, are also very suitable for household furniture. This item has been certified for the State Emblem of Quality. This year it is planned to produce more than a million units. But even this amount apparently will not be enough to satisfy the furnituremakers' demands.

The casters have occupied a firm place in the "Production of Consumer Goods" Schedule. Today another product--hockey ice skates on a plastic chassis--is drawing close to them. But these were not produced in our country until recently. The All-Union Industrial Design-Development and Design Institute for the Production of Sports and Tourist Products (VISTI) proposed that the machine-tool components plant master the output of the new product. It was decided to manufacture the ice skates entirely from two parts--steel runners and a plastic frame (for comparison: metal skates have eight parts). It turned out, however, that even the strongest grades of plastic are inferior to metal and are not suitable for this article. Pliable, flexible materials were needed. A new replacement was found as the result of a lengthy search.

The production of ice skates in the new "formulation" enabled the number of engineering documents to be reduced, no few workhands to be released, and metal to be saved. The annual economic benefit was 96,500 rubles. Well, and what is the quality of the new skates? Specialists are unanimous in their opinion: they meet the strictest requirements.

The Gomel production facility's ice skates were awarded the gold medal of the Insport-82 exposition at Brno (Czechoslovak Socialist Republic). For its contribution to the development of hockey in our country, the machine-tool components plant was awarded an Honorary Certificate of the All-Union Review of Sports and Tourist Commodities, which was conducted by the newspaper SOVETSKIY SPORT. A decision of the Artistic and Engineering Council of USSR Sportkomitet [Sports Committee] assigned the ice skates to the best-quality products category, with the award of an "N" index. Each year the number of orders that arrive from the RSFSR, Ukrainian, Estonian and other republic trade organizations grows. This year alone it is planned to produce 70,000 pairs of the skates.

GZSU does not stop at what has been achieved. The factory workers, for instance, are pleasing housewives. By the end of the year models of mechanical graters for vegetables, and then scissors made by cold stamping, which will greatly reduce labor intensiveness, will permit serial output of these products to be set up at once. They will be produced in aluminum and later in plastic versions. Already this year, consumer goods comprise 7.8 percent of total production volume.

You do not call the Gomel Machine-Tool Components Plant a giant. What is more, its products will not astonish the imagination: the largest machine tool will fit on a table, and the caster will fit in the palm of one hand. The GZSU's experience testifies that great feats can be accomplished at even a small plant.

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METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

CHANGING PRODUCT MIX OF KIROV PLANT REVIEWED

Minsk NARODNOYE KHOZYAYSTVO BELORUSSII in Russian No 10, Oct 84 pp 28-29

[Article by Kirov Plant director G. Kazakov and candidate of historical sciences V. Rayskiy: "With Sights Set on the Future: The Alliance of Science with Production"]

[Text] A machine tool-building enterprise is known as a "plant among plants". This sector is represented in worthy fashion in our republic by the collective of the Gomel plant imeni S. M. Kirov. Fifty years have passed since the first machine tool was assembled here. Output at this plant has undergone striking changes during this time. Equipment with NC, of the "machining center" type, is now manufactured here.

Plant director G. Kazakov and candidate of historical sciences V. Rayskiy discuss the enterprise's present and its future prospects.

Almost all the series production put out by the Kirov plant workers over the past few years has borne the State Mark of Quality. In spite of that, the needs of machine-builders require ever more strenuous effort to improve it, and ever more focus on the future. Four years ago enterprise specialists worked up the technical specifications for the manufacture of multi-purpose drill press-milling machines equipped with a cross table, NC, automatic tool change and billet feed. The changeover to the manufacture of new equipment demanded that a major organizational and technical restructuring of production be carried out in a short time. The plant had to get rid of its abundance of multi-purpose machine tools. What would they replace them with?

The frequent change in the array of products and models and types of machine tools which were manufactured, and the improvement of the fixed capital were processes which proceeded in parallel at the plant. The second process included not only the renovation of operating equipment, but the improvement of the system of mechanization and automation of production as well. Constant capital investments were needed. What's more, these outlays, which were made during conditions of rapid renewal of output, as well as its being produced in small series, have not been reimbursed.

Three basic stages in the improvement of the fixed capital have been determined in the history of this plant. The first is the period of mass production of machine-building products and the transition to specialization in machine tool building. The second is the period of mass manufacture of all-purpose and special-purpose machine tools. Readjustable automatic production lines made their appearance. This made it possible to maneuver the production equipment and increase labor productivity.

With the transition to the manufacture of NC machine tools and machine tools of the multi-purpose "machining center" type, the third stage was inaugurated. Automatic machine tools with flexible programs have been introduced, as have NC machine tools. There are over 70 such machine tools at the plant today. These are universal machine tools, and are equipped with electronic computing devices which multiply their productive potentialities. The program devices are also universal, effective and technologically efficient. They attain utmost productivity and they reduce the need for a skilled work force.

Thus, Kirov Plant workers have discovered a way to avoid the contradictions of the two processes: the rapid change in the list of products, and the process of renewing the fixed capital, which required massive outlays.

By virtue of the fact that basic production in the plant is in a state of dynamic growth, the proportions which have been established between the subsections are in a constant state of flux. These changes result from the growth and development of the enterprise. Until recently, only 48 units of forging and pressing equipment were accounted for by some 600 metal-cutting machine tools. This indicator is one-third less than the average for the country. There was an adverse effect caused by the fact that new equipment arrived at recently-constructed plants, but the stock of available machine tools used at the operating enterprises was not even begun to be renewed until the 70's, and these enterprises were unsuccessful in obtaining the forge-pressing machine tools which would most closely bring the form of the blank to that of the finished part. The transition to manufacture of new machine tools demanded an abrupt improvement in the structure of the equipment.

A no less important trend is that of renewing and improving the stock of lathes and grinders. There were only five lathes at the imeni S. M. Kirov, with grinders comprising only a tenth of the entire machine tool inventory. New highly-accurate machines made up 65.7 percent of the lathe stock. Their "growth" took up to 10 years. To a certain degree this has made up for the shortages in lapping and finishing equipment. To be sure, the plant's potentialities were greatly expanded as a result of the saturation of the production sections with NC and precision machine tools. The increase in the stock of NC machine tools was accompanied by a significant increase in the relative share of parts which they machined. Compared to 1975, this indicator increased more than 12-fold in 1980.

The Kirov plant workers are constantly analyzing the relation between groups of equipment and the sections and shops. This analysis makes it possible to detect superfluous equipment, to preclude any disproportion in the structure of the machine tool stock, and not to tolerate any reduction in the factor

of utilization of productive capacities. If the relative share of the overall value of the fixed capital amounted to 55.1 percent for equipment in 1975, and the factor for utilization of productive capacities came to 0.96, then after five years these indicators came to 53.4 and 0.99 respectively, and the output of products per single machine tool increased by almost one third.

In order to insure proportionality in the development of the productive capacities, strict control has been imposed over the manner in which the production program is altered and the subdivisions are specialized; consideration has been made for technical, organizational and social factors upon which fullest utilization of the equipment depends, as well as the work-load and shift-work factors depend; analysis and record-keeping of the actual utilization of capacities in the sections has been set up etc.

In their projections for the gains to be made during the 11th Five-Year Plan period, plant workers counted the expected structure of the machine tool capacity with regard to the products manufactured. These are dynamic data, in the sense that a flexible products list calls for changes in product volume as well as in production procedures. Thus, in 1970 milling jobs constituted 9.6 percent, and this will increase almost 2-fold by 1985. The relative share of operations carried out on vertical boring and turning lathes and gear cutters will be reduced by almost one half prior to the end of the five-year plan period. These calculations, which have been fixed in the enterprise's standard concerning the smooth working of its sections, make it possible for the Kirov Plant's workers to keep tabs on the flexible structure of their production capacities and to detect superfluous or little-used equipment, and then to utilize it to maximum effectiveness. Computers are a great help here. The KVTs [group computing center] worked out a work-load computation for each unit of equipment.

In two machine shops, there are three integrated sections at work, with NC machine tools of the milling, boring, drilling and lathe groups, and in the third machine shop (Shop No 5), the IR-500 and IR-800 multi-tool models. Twelve percent of the labor intensiveness of the mechanical machining of basic production falls to these sections, and in this connection the labor intensiveness of parts manufacturing has been reduced by 21,000 norm-hours. The results seem to be exceptional. But at the same time, new equipment in this plant is not being used to its full capacity. This is a problem which is having an adverse effect on the labor force.

The workers at the Kirov Plant constitute a stable collective. Almost 70 percent of its members have been working here over 10 years and about 200 persons, from 25-30 years. Qualified workers make up 96.7 percent of the work force, and the average skill category comes to 3.3 on a scale of 5. But the machine tool engineers do not consider this to be their limit. The present-day level of professional training attained by these workers makes it possible to initiate production of new, up-to-date machine tools. There are numerous examples to attest to this. The first multi-purpose drilling-milling machine tool with NC was turned over in a record short time--after six months, and it was then left in a machine shop for comprehensive testing. This was in 1981, and after a year the SAKM-26 complex line of NC machine tools

complex was expanded. The collective initiated production of automatic equipment with a horizontally mounted spindle which increased the range of uses for these machines. After another year, the plant developed the following innovation--a multi-purpose horizontal drilling-milling-boring machine tool with NC and an automatic tool and blank feeding system for machining parts from five directions. Its success is indisputable.

However, in order for production of several models of even a single unitized complex of machine tools to be initiated, the work forces of all links--from workers to engineers--should be retrained. This involves a number of complications. In the first place, we need an excellent educational materials base. Second, we need specialists and teachers. Third, this plan will not succeed without a clear-cut system for organizing the course of training (programs, learning manuals etc.). In short, a combination of problems.

In these conditions, they say: "You need to get around and assimilate the experience accumulated by other machine tool builders". And this is being done. However, little effectiveness has been derived from these trips. And this is understandable. Totally new production methods and new processes do not "superimpose" well on customary approaches and working methods. In the absence of definite theoretical training, it is difficult to adopt that which is new. The variety of production conditions has to be considered as well. These are precisely the factors which preclude the mechanical copying of the processes which have been refined and which have given good account of themselves at other enterprises. Consideration must also be made of the fact that the new machine tools unite into a single process operations which were formerly carried out separately, on an individual basis, such as turning, lapping, boring, milling etc. It takes a specialist with a wide range of skills to service such equipment, one who has had excellent theoretical training.

From everything said above, this conclusion follows: that it is high time we had, on the scale of an industrial city, and even if only one, a center for the skill training and cross-training of those working in the mass skills, training courses in servicing new equipment, computer language training, programming basics and the operation of modern equipment. It is no less important for us right now to have, attached to the plant, its own center for the training of the work force, so as to make them capable of competent operation of the machine tools in their own industry. This will prevent the machine tools from breaking down prematurely, and will more closely link the "producer-plant--client-plant" network.

The main directions for the development of this plant were determined as far back as the end of the 70's. In their long-term plan, the Kirov Plant workers also included a forecast of increasing demands on the part of the consumers of the plant's output. Today, the national economy needs not only technically perfected machine tools, but the optimum procedures for machining parts as well. So what good does the forecast of the consumers' demands do for the plant?

First, the current prospective capacity of the consumer market has been determined. Second, the contours of our productive specialization are showing up distinctly and we now are being availed of the opportunity to forecast the structure of our inhouse productive capacities as well as the demand for material and technical support. Moreover, the producer-plant can now plan its operation so as to set up a mobile production process through the use of state-of-the-art equipment, computer systems, can restructure itself rapidly, increasing its capacities without expanding the manufacturing area, and can do so using the least number of workers by using flexible manufacturing systems.

It is no less important to find a solution to the problem of the robotization of in-house production and of the machine tools being produced. The concept of manufacturing robots and manipulators in a single center, with their subsequent tie-in to the equipment at the operating site, is hardly acceptable. In our view, the robots and manipulators ought to be made part of a specific machine tool. Their development, manufacture and program parameters should be correlated with the operating equipment and the potentialities of its realignment. In other words, the development of a new machine tool ought to proceed simultaneously with the development and manufacture of the robots and manipulators. Then the customer will receive a complete machine tool/robot unit.

The transition to the manufacture of machine tools of the "machining center" type has raised another problem--that of cooperation--in a new way. The Min-stankoprom system has specified the plants which are providing cooperative deliveries of assemblies and units for AKM26-5 complex machine tools. However, for their efforts to be best coordinated, and for the most effective solution to a number of design and manufacturing problems the plant needs an SKB [special design bureau] center. There are obviously insufficient workers in the plant's own design bureau to solve these problems. The complexity of the problems faced by the machine tool builders lies also in the fact that the process of upgrading the output by using "machining center" type machine tools is done in the process of the mass manufacturing of series-produced and special multi-purpose machine tools. This plant remains the Council for Mutual Economic Assistance's leading enterprise in the manufacture of abrasive cutting-off and slotting machines. This imposes a high responsibility on the Kirov plant collective. The development of an aggregated complex in combination with widespread standardization makes possible the creation of a flexible planning system out of a limited number of standardized machine units and assemblies while taking the variety found in the requirements into consideration, in the first place. Second, better conditions for cooperation with other enterprises will be created, and there will be an increase in batch production in the manufacture of assemblies and parts, thus reducing manufacturing time and outlays for machine tools, while increasing their quality. Introduction of these aggregating complexes will effect a significant saving of material and labor outlays for the national economy. Such is the prospect which has become the general direction in the development of machine tool production.

Of course all our plans will remain on paper if there is insufficient enthusiasm, skill and skillful organization of labor to carry them out. It would be appropriate here to say a word about the collective which services the

NC machine tool section. Bringing the work force of this section up to strength was no simple matter. At first, the installed machine tools worked at only half capacity. Having worked alongside all-purpose machine tools for piece-rate wages the machine tool operators, afraid of losing wages, were in no hurry to change over to the new equipment. Mastery of a new machine tool is always a difficult affair, and all the more difficult for machine tools with NC. And many of them worried that what if nothing came of it? And, too, the different nomenclature of the parts which the section was supposed to "put out" was confusing. Far from all of these parts were "profitable". And the fitters needed full sets of parts. Many parts are made in small lots, and some individual parts were one-offs, which required a multitude of readjustments.

The organization of the integral-process contract brigade in the section turned out to be a complicated affair. However, the advantages of setting up brigade contracts became apparent very quickly. The collective consists of 43 workers: lathe operators, milling machine operators, grinder-polisher operators, drill operators and adjusters. These people are differentiated as well with regard to age, to their family situations, and to their character. The highest category is the fifth. But foremen such as the lathe operators V. Stankevich, O. Kontsevoy, V. Novikov, V. Matveychikov, M. Bazutov, V. Balyunov and L. Azarov--not many--are mostly young. Adding up its reserves, the brigade has taken increased obligations upon itself for this year: to go over to mass production of 2nd-class precision parts for the IR 500 machine tools, to reduce the prime cost of their output by one-half percent compared to that planned. Last year the brigade enlisted into their ranks the former plant lathe operator, Hero of the Soviet Union and naval aviator Captain I. B. Katunin, who duplicated the feat of Captain N. F. Gastello during the war. He was awarded time-board number 1944. This is the year of the hero's death. Wages are accounted for I. B. Katunin in accordance with the KTU [coefficient of labor participation], which is authorized by a general brigade meeting, and are tabulated as part of the Soviet Peace Fund. The plant already has 84 brigades working by the brigade contract method. These brigades unite 92.6 percent of the plant's workers.

* * *

In the 50 years which have passed since the first machine tool was manufactured the Gomel machine tool builders have manufactured about 95,000 metal-cutting machine tools. This is almost 2.8-fold greater than the total number of units in the machine tool inventory of prerevolutionary tsarist Russia in 1913.

At present, there are machine tools bearing the Gomel trademark in 56 countries of the world. They are in great demand in the United States, England, France, Japan, the FRG, Italy, India, Canada and other countries, and have been distinguished by prizes at many international expositions.

These achievements of the Kirov Plant workers are quite in order. For ten years, the contract collective has borne out the elevated status of a communist labor enterprise. This is a great honor for the machine tool builders, which

at the same time imposes additional responsibilities on them regarding the results of their work. In this frame of mind, the collective starts a new page in its biography, a page which doubtless will be filled out with new remarkable feats and accomplishments.

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OTHER METALWORKING EQUIPMENT

BRIEFS

NEW NOVOLIPETSK PLATE MILL--Lipetsk--A new plate-rolling department will rise up at the Novolipetsk Metallurgical Combine. Concreting of the thick monolithic footing for the "1400" rolling mill is going on around the clock. Simultaneously the skeleton of the main building is being erected. Work is going on well ahead of schedule. Creation of the highly mechanized complex will supply the country's electrical-equipment industry with a special steel which will enable electric motors of like capacity to be reduced in weight. After the department is turned over for operation, industry will be able to increase output of the economical motors by almost a third. The facility's first line should go into operation in 1986. The work pace adopted will ensure the fulfillment of high socialist commitments. [Text] [Moscow SELSKAYA ZHIZN in Russian 14 Dec 84 p 1] 11409

TRUCK PLANT AUTOMATION--Zaporozhye--Equipment created by Zaporozhye's specialists in collaboration with scientists of the Institute of Electrical Welding imeni Ye. O. Paton of the Ukrainian SSR Academy of Sciences will enable the assembly and welding of truck bodies and cabs to be completely automated and mechanized. They have worked out a whole range of assemblies and robots from which highly effective production lines can be made up. Deliveries of such equipment from Zaporozhye to the Kutaisi Motor-Vehicle Plant has begun. [Text] [Moscow SELSKAYA ZHIZN in Russian 17 Nov 84 p 1] 11409

ESTONIAN FERROUS-METALLURGY PLANT--Tallin--The Tallin Department of Estonia's Vtorchermet Association has gone into operation after rebuilding. A giant press has been installed in the department. In mere minutes it processes scrap metal into compact blocks of 1½ tons each. Introduction of the powerful unit has resolved several problems at once. Primarily, the quality of secondary raw-materials processing was raised. At the same time, as a result of full use of railroad-car loading, the requirement for such cars has been halved. [Text] [Moscow SELSKAYA ZHIZN in Russian 7 Feb 85 p 1] 11409

BELORUSSIAN INDUSTRIAL LASERS--Gomel--Special optical systems developed by Belorussian scientists have helped to make laser welding still more speedy. The quantum generators they have supplied are being used not only for welding but also for precision quenching and heat treating. The light ray of complicated form cuts glass and ceramics more quickly and better than diamond. [Text] [Moscow SELSKAYA ZHIZN in Russian 4 Jan 85 p 1] 11409

PLASMA-SPRAY HARDFACING--Volgograd--The production-association collective has mastered methods for rejuvenating parts of machines by hard-facing through plasma spraying. This will enable scarce materials and nonferrous metals to be saved. The cost of restoring one part does not exceed 5 rubles [Text] [TASS] [Moscow EKONOMICHESKAYA GAZETA in Russian No 8, Feb 85 p 7] 11409

MINSK-PRODUCED LATHE POSTPROCESSORS--Postprocessors for NC lathes that were developed by the Minsk Branch of Orgstankinprom [State Industrial-Design and Experimental Institute for Organization of the Machine-Tool and Toolmaking Industry] have been introduced at Minsk's Oktyabrskaya Revolyutsiya Plant and Plant imeni S. M. Kirov and at the Vitebsk Toolgrinding-Machinery Plant. Introduction of the new postprocessors will help to reduce the labor intensive-ness of preparing, monitoring and punching information for controlling machine-tool equipment. [Text] [Minsk SOVETSKAYA BELORUSSIYA in Russian 21 Dec 84 p 2] 11409

GANGED GRINDERS FROM ORSHA--Orsha (Vitebsk Oblast)--A complex of metal-machining equipment with the brand of Orsha's Krasnyy Borets machine-toolmaking plant is replacing a brigade of skilled grinders. The first lot of such units has been sent to the country's machinebuilding plants. The inclusion of industrial robots and automated transporting devices in machine-tool complexes will enable one of the most labor-intensive operations--the deep grinding of grooves--to be performed in an automated mode. These units will help to save the labor of blue-collar workers by converting them to the tending of ganged machine tools, and they will raise output quality. [Text] [Moscow SELSKAYA ZHIZN in Russian 11 Dec 84 p 1] 11409

SHIPBUILDERS' INDUSTRIAL LASER IMPROVED--Leningrad's Intensifikatsiya-90 program calls for a great increase in installations for laser, electrophysical and electrochemical machining methods. Shipbuilding-institute instructors S. Semenov, B. Vsevolodov and S. Pastukhov have developed an industrial laser module. It can do welding, cutting, hard-facing and even alloying. The technology that has been developed for using the working beam has been recognized by a gold medal of VDNKh SSSR [USSR Exhibition of Achievements of the National Economy]. "We managed to find a basically new solution and expand the range of use of laser devices," said Chief Designer Candidate of Engineering Sciences S. Semenov. "The amplitude of the beam's oscillation has grown through oscillation of the mirror. This has also enabled the laser's potential to be increased." [Col A. Yurkin] [Text] [Moscow KRASNAYA ZVEZDA in Russian 7 Jul 85 p 1] 11409

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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

DRAWBACKS TO CERTAIN FLEXIBLE PRODUCTION SYSTEMS NOTED

Leningrad LENINGRADSKAYA PRAVDA in Russian 14 Mar 85 p 4

[Article by Doctor of Engineering Sciences Professor P. I. Chinayev, laboratory manager of the AN SSSR Institute of Mechanical Engineering: "What Should the Plant of the Future 'Be Able to Do'?" ; passages enclosed in slantlines printed in boldface]

[Text] "Above all, be resettable quickly--on the go, as they say--for manufacturing new types of products," is how Doctor of Engineering Sciences Professor P. I. Chinayev, laboratory manager of AN SSSR [USSR Academy of Sciences] Institute of Mechanical Engineering, answers the question posed by the headline.

I shall begin with a paradoxical question: is all automation good? More precisely: can it be said of each automation that it is the high road to production intensification?.

A third of a century ago an automatic plant built in Ulyanovsk was much admired. Pistons were then manufactured there in a continuous stream for the nation's motor-vehicle assembling enterprises. And suddenly...the plant was dismantled. This proved to be more suitable than to readjust to the production of new pistons for more modern motors. Flexibility--this is what the plant lacked. "Rigid" automation of its production lines "cheated" the automated plant out of the "capability" for timely resetting of the machines.

And even today we are still habitually accepting it: once it is decided to produce a new product, that means new departments or new plants will be built for making it....But indeed /the most modern product nowadays, in the era of the NTR [scientific and technical revolution], becomes obsolete very quickly./

Scientists and designers saw the way out of this not very favorable situation (from the economic and technological, as well as from the demographic and ecological points of view) a fairly long time ago. It was clear that /it was necessary to rethink the technology and organization of all production to make it flexible/ (multivariant), based upon automated resetting of the equipment. However, the inadequate development of computer technology and lack of the necessary equipment prevented implementation of this way out up until a certain time.

This technology and equipment now exist. NC machines--machining centers and machine tools, as well as industrial, measuring and transporting robots capable of being reset rapidly for the manufacture of new types of articles--were created in the last 10 years.

The next step was the combining of these machines into "brigades" and the creation, based thereon, of flexible production systems (GPS's), and then flexible automated production facilities (GAP's) were created from them.

Take, for example, the GPS that was created by Ivanovsk machine-toolmakers. They named it the Talka-500. It included two machining centers, transporter robots and a computer-assisted control complex. The flexibility of the machining centers was founded on their universality--their capability to accomplish practically all operations available in the machinebuilding arsenal. These centers "know how" to ream, mill, drill and bore parts, to cut threads and to do turning and grinding operations. The central minicomputer, which is "associated" with the microcomputer built into the machine tool and with the transporter robots, gives the orders to perform one operation or another (in accordance, of course, with the program on which it is based). In accordance with these commands, the robots bring up and install the blanks, pick up the finished parts and send them off to the warehouse or to the assembling department.

Obviously, a plant supplied with such equipment does not have to be dismantled when it converts to the output of a new product. However, another question arises: isn't such automation wasteful for an enterprise? Yes, flexible production is not cheap. That is why it should be used with wisdom. Analysis and experience suggests: resettable and flexible equipment makes sense when used for mass production of 5,000-10,000 articles of 10-500 specific types per year, and also for experimental and single manufacture of new types of output.

This is today. And tomorrow? Tomorrow, first, GPS's and GAP's themselves will become cheaper. And, second, it is assured that our production personnel will be taught to use them in such a way as to get maximum workload utilization from the valuable equipment. In particular, the idea of creating flexible automated interagency regional centers is already being discussed. In other words, /that which is not suitable now for a single plant can be suitable for several neighboring enterprises./ It is true that, for this purpose, agency barriers will have to be overcome, but these are matters of an organizational nature.

One thing is evident: flexible automated production facilities in this day are the most promising direction for the development of comprehensive automation. Among their virtues is the fact that they can be assembled and configured from modules the same way children assemble their "buildings" from blocks. Of course the "blocks" are more complicated here--machining centers, robots and other equipment--but the principle is the same. Using it will enable GPS's to be erected--module by module--in accordance with the plan for rebuilding a production facility, and GAP's to be created from them. Such a way of introduction will reduce considerably the time spent creating flexible systems and production facilities by 9-10 months. Moreover, the selection of modules and blocks and the best arrangement of them will enable the

structure of GPS's and GAP's to be optimized. The module-block structure also will increase GAP reliability considerably, allow GAP's to be made as self-repairing production facilities (by prompt replacement of blocks or modules), and call for reserve equipment and instruments.

A flexible automated system is constructed in complicated fashion, and its structure is not ordinary. It is both modular and hierarchic (multiple-level). The production and assembly of articles are the bases of its components. Here, machine tools and other industry equipment "toil," and manipulator robots and transporters "work" automated storage complexes. The second component is hierarchic automated control by means of a system of computer and adaptive switching devices, microcomputers and microprocessors, which are built into the machining centers and the robots. A very important automated component of the flexible production facility is the technological preparation for production. Here the search proceeds for the best technology for manufacturing the articles, the settings for machining the parts, and the tooling needed for this....

It should be specially emphasized that this work is done in collaboration with the system for automated design--SAPR.

A person sets up on a keyboard the data about the required part. The data are entered into the computer and a drawing of it, with dimensions, is shown on the display. If the designer does not construct something, he enters new parameters into the computer, and the drawing is changed. The program for machining the part is worked out for the final variant and is sent into the memory of the machining center's microcomputer.

And, finally, the control for the whole production facility unites and "integrates" all of these components by means of the central computer. It has a direct tie with a library of programs, a data bank of drawings of parts and components, devices for automated monitoring, diagnostics, documentation, reporting and planning. It is /this which provides the flexibility--the quick adaptability to all changes in the production activity and outside it./

It is agreed that even this extremely sketchily drawn picture of the flexible production facility operations will seem unusual to most readers. This is why many consider that GPS's and GAP's are a matter for the future. Of course the real scope of their application is still far off, but nevertheless /several dozen flexible production complexes are already operating today at our country's enterprises./

Their "life and activity" are attracting the tireless attention of specialists. And this not unexpected--experience in operating the flexible production facilities created by Soviet scientific and design organizations are paving the way to horizons so wide that they could only be dreamed about under past technology. For example, the intensity of equipment utilization is increased 6-fold to 7-fold. At all production stages--from design to the assembly of an article and to the monitoring of its quality, /labor productivity grows greatly, and there are opinions that eventually it can be increased tens of times, reducing, in so doing, the number of production workers 20-fold to 30-fold./ The operation of flexible production facilities in three shifts (at night entirely without people) will raise the equipment's utilization factor up to 2.6 or even 3.

/The introduction of GPS's and GAP's everywhere will enable heavy and manual labor to be completely eliminated, and the labor shortage to be resolved./ All this will affect the living conditions of all Soviet people, of each one of us, most favorably. The CPSU Central Committee and USSR Council of Ministers decree, "Measures for Accelerating Scientific and Technical Progress in the National Economy," emphasized especially the need for the most rapid development of work in the area of creating flexible automated production facilities and automated design systems. Many important problems must be solved in carrying out the tasks set for scientists and specialists of various industries. It is not accidental that the complexity and significance of developing flexible automated production facilities are commensurate with the problems of conquering outer space.

Unfortunately, not always do production workers accept with applause new equipment and new technological ideas. Because each innovation requires not only a definite restructuring of production but also a definite change in thought and habits. Automation, moreover /is a most severe "examination" of the precision, teamwork and discipline of all production elements./ And each person must be prepared for this. Only a combining of the achievements of the scientific and technical revolution with the advantages of the socialist system of economic activity will permit us to build the plants of the future.

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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

JUSTIFIED FLEXIBILITY OF AUTOMATED PRODUCTION LINES DISCUSSED.

Leningrad DVIGATELESTROYENIYE in Russian No 5, May 85, pp 20-23

[Abstract] In the creation of a flexible automatic production facility, in addition to optimizing the spatial structure based on goal orientation and program coordination of input and outputs, adequate construction of the control portion is also necessary. This article discusses the structure of the operational-production planning subsystem, the automated operational administrative section built into the automated production control system. The major purpose of the operational-production planning system is to organize time and space coordinated movement of products and their parts within the flexible automated production facility. The criteria for achievement of this goal include full, complete and uniform performance of the production program in a timely manner; efficient utilization of equipment and supplies; and maximum acceleration of production with minimum utilization of capital funds. The key section of the automated operational administration system consists of calendar norm computations. Equations are derived for the computations, which can be used to determine the economically justified degree of flexibility of multiple-process automated production lines. Using these equations, management can determine the economically most justified number of times the production process and its output can be modified within the course of a year.

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